From: poul hertel [poulh@erols.com]
Sent: Monday, November 19, 2007 4:16 PM
To: Darton,Terry
Cc: Dowd,Michael
Subject: Comments on the Proposed Stationary Source Permit to Operate Dated October 19, 2007 For Mirants PRGS

Dear Mr. Darton

Please find enclosed comments regarding the State Operating Permit.

Sincerely

Poul Hertel

1217 Michigan Court
Alexandria Virginia 22314

Richard D. Langford, Chairman
Bruce C. Buckheit
John N. Hanson
Hullihen W. Moore
Vivian E. Thomson

State Air Pollution Control Board
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

Re: Proposed Stationary Source Permit to Operate Dated October 19, 2007
Mirant Potomac River Generating Station, Alexandria, Virginia

Honorable Board Members

Seven years ago, we embarked on a scientific journey to find out what was coming into our neighborhood, where it came from, and was it harmful. We had hoped for benign results, but instead, the science confirmed our worst fears.

Our report dated August 20, 2003[1] raised two issues, the short smoke stacks and the harmful effects of $PM_{2.5}$ (see attachment 1, Health Effects plant concerns and conclusions).

> ""Epidemiological work conducted over several decades has shown that long-term residence in cities with elevated ambient levels of air pollution from combustion sources is associated with increased mortality". Subsequent studies found a strong relationship between not only sulfates and mortality but also fine particulate matter (all particles less than 2.5 microns in median aerodynamic diameter [PM2.5]) and mortality rates.
>
> Conclusive evidence of the adverse effects of air pollution and mortality has been around for years. However, recent research has focused on a more narrow scope of parameters.
>
> These studies demonstrated conclusively that the pollution levels needed for harmful effects were much smaller than expected and that fine particulate matter contributes to excess mortality. These findings included statistical techniques in which individual risk factors, like smoking habits, were factored into the study."[2]

[1] Mirant Power Plant, Emissions and Health Effects Report; Elizabeth Chimento and Poul Hertel. *August 20, 2003*

[2] Page 10, Ibid.

Subsequent studies, notably

- Dave Sullivan *"Screening Level Modeling Analysis of the Potomac River Power Plant Located in Alexandria, Virginia."*

- AERO Engineering Services, *"Ambient Air Quality Analysis- Potomac River Generating Station- Alexandria, Virginia."*

- ENSR Corporation, *"A Dispersion Analysis Modeling Analysis of Downwash from Mirant's Potomac River Generating Plant"*.

- Department of Energy, *"Special Environmental Analysis For Actions Taken under U.S. Department of Energy Emergency Orders Regarding Operation of the Potomac River Generating Station in Alexandria, Virginia."*

Have all demonstrated the existence of downwash effects in the neighborhoods surrounding the plant. AERO Engineering study provides a more schematic and illustrative measure showing how the matter ejected from the smokestacks actually falls right on top of us. (technically see more precise definition bellow)

What is downwash?

Downwash is a vertical velocity component precipitated by the presence of vortices on top of buildings, which instead of allowing the smoke to rise sucks it down to the ground.[3]

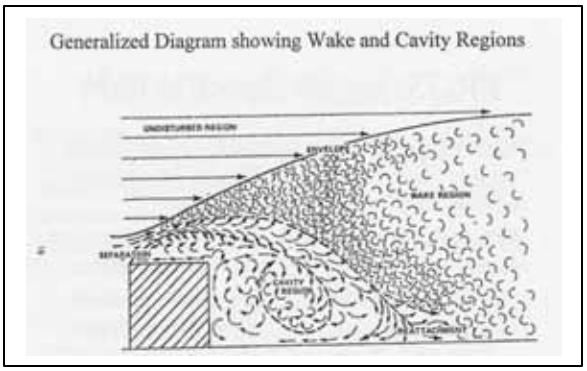
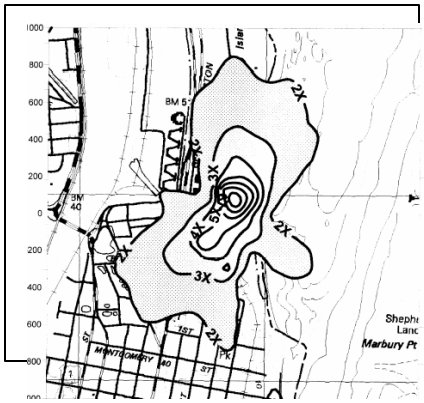


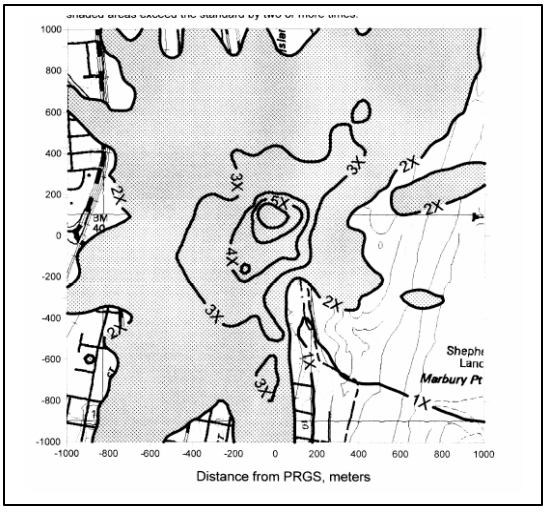
Table 3-4. Maximum Total Impacts of $PM_{2.5}$, PM_{10} and SO_2 (µg/cu.m.) at Sensitive Receptors with the Greatest Impacts.

	PM 2.5		PM_{10}		SO_2		
Location	**24-hr.**	**Ann**	**24-hr.**	**Ann.**	**3-hr.**	**24-hr.**	**Ann.**
1300 Michigan Ave.	181.	25.	203.	31.	3,828.	2,076.	132.
Pitt Street Station	196.	29.	274.	41.	3,887.	1,858.	148.
Virginia Villlage	151.	23.	163.	28.	3,383.	1,527.	105.
Canal Way	141.	24.	170.	31.	3,606.	1,304.	110.
Chetworth Park	133.	20.	140.	25.	3,339.	1,284.	76.
St. Anthony's Daycare	132.	24.	132.	32.	3,824.	1,150.	103.
Old Town Gateway	132.	22.	140.	27.	3,406.	1,301.	98.
Salvation Army	127.	20.	147.	26.	4,129.	1,455.	75.
Giant Food Store	121.	22.	140.	28.	3,394.	1,081.	93.
AAQS							
	65.	15.	150.	50.	1300.	365.	80.

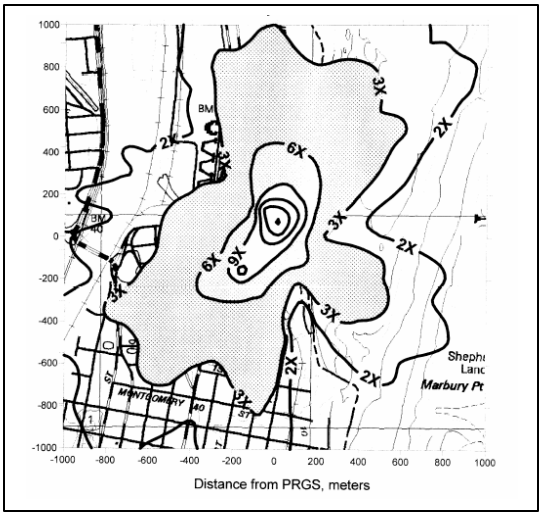
PM (2.5)



Sulphur Dioxide 3 hour impact



Sulphur Dioxide 24 hour impact



[3] Source: AERO Engineering Services, *"Ambient Air Quality Analysis- Potomac River Generating Station- Alexandria, Virginia."*

Note that during some days, one can literally delineate when entering into a downwash zone by smelling the SO_2, and or developing itchy eyes, coughing and breathing difficulties. If you think these are the notations of a single person that can be readily dismissed, I suggest you listen to my neighbors. Far too many are reporting the same symptoms for you to push these concerns aside.

Since the use of Trona, substantial "dust presence" has materialized that is significantly different from previous observations. The dust is much heavier than previously, and more granular. Clean rooms will suddenly be covered with residue within the span of a day. The smell of Sulphur is much more pervasive than previously. Breathing can sometimes feel as if the lungs are bound by a barrel. The eyes are itching all the time. Amazingly enough, and as stated previously, most symptoms disappear outside the effected area.

In 2001 Mirant assured us that

- The ventury takes care of any downwash
- Based on these findings, it appears that the deposits from the Pitt Street residence can be classified as 'common dirt'[4].

Both statements have been debunked by science. Now we are expected to take it on faith that Trona works and is safe. Yet our experience suggest otherwise. We are seeing substantial side effects that are far in excess of any benign product I know of, and downwash is still very much present.

We have come a long way in our collective understanding of the health effects emanating from this plant. No longer can the problems be panned of as "common dirt" as the plant reported in 2001. No longer do we accept urban legends, which conjecture that the dangerous stuff flies far away, or if not, then it blows mostly to the north. Instead, we look to scientific approaches to ascertain what the health effects of the plant are.

Penn State, the Virginia Department of Environmental Quality, Jonathan Levy, Dave Sullivan, among others, have provided numerous scientific research papers and tests, all of which validate our initial concerns.

So the "common dirt" is not so common and the stuff does affect us because particulate matter matters. Furthermore, the peculiarities of the plant create conditions that further compromise the health of the surrounding urban residential area in a significant manner.

The SOP seeks to control the Sulphur Dioxide through limits and by using Trona and low Sulphur coal. However, and ironically enough since our original report dealt specifically with PM, the SOP is notably lax in ensuring that Particulate Matter will comply with the NAAQS.

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[4] Mirant Intracompany Correspondence To Ms. D. Knight Date July 24, 2001 From Alex Bonnington Subject Sta-C Pitt Street Deposits, MLN2001-246

Soren Kirkegaard wrote about religion ultimately coming down to a leap of faith. However, science as moved beyond the wings and a prayer approach contained in this SOP. Many of us bear the physical scars living next to the plant. Rather unfortunate since the science is available to ensure NAAQS compliance and makes it unnecessary for us to sacrifice our health at the altar of regionalism.

Specifically:

- It is imperative that impacts of $PM_{2.5}$ emissions from the PRGS be assessed and NAAQS-compliant emission limits be established in the permit.

- Based on optimized operation of the source and the pollution control measures, and compliance with the NAAQS, the limits in the SOP must not exceed the following:
  SO_2 < 0.30 lb/MMBtu (trona optimization)
  NOx < 0.22 lb/MMBtu (LNB/SOFA optimization)
  PM < 0.03 lb/MMBtu (ESP performance)
  PM_{10} < 0.02 lb/MMBtu (ESP performance)
  $PM_{2.5}$ < 0.003 - 0.012 lb/MMBtu (NAAQS compliance)
  CO < 0.20 lb/MMBtu (BACT)
  Hg < 37 lb/yr (actual baseline emissions)
  Coal sulfur < 0.9 wt% (current limit for PRGS)

- Short term (hourly and daily) emissions are arbitrary and unreasonable. They must be revised to reflect actual performance and operations at the PRGS.

- Annual emissions must not exceed baseline emissions during the most recent 24 month period, i.e., Fall 2005 through Fall 2007. For PM_{10} and $PM_{2.5}$, the annual average baseline emissions during August 2005 through June 2007 are estimated using stack test data to be 135 and 116 tons/year, respectively. [5]

- **Baghouses must be required on all five boilers at the PRGS.**

- CEMS for CO and PM must be required on all five boilers as soon as possible. The PM_{10} and $PM_{2.5}$ fractions identified during the stack tests required by the SOP must be used in conjunction with the PM CEMS data for continuous compliance purposes.

- Reference to trona as a PM control must be removed from the SOP.

- All NSR issues must be promptly resolved. This includes (1) past NSR violations for LNB, SOFA and trona installations, (2) increase in the maximum heat input rates as compared to the rated capacities as listed in PRGS's current SOP, and (3) use of an alternate sorbent other than trona. The SOP must not be used to pre-authorize the

[5] As of the date of this letter, data from the PRGS was only available up to June 2007 on the EPA's airmarkets website. Upon availability of plant data for the quarter ending September 2007, Alexandria recommends that full 24 months of data be used during Fall 2005 through Fall 2007. Data prior to August 2005 are not appropriate for baseline estimation because emissions during that period were shown to violate NAAQS.

use of sodium bicarbonate or another alternate sorbent without thorough evaluation and a pre-construction permit. Also, a pre-construction NSR permit must be issued for the stack merger project if Mirant wishes to pursue this project.

- The SOP must be practically enforceable and require adequate monitoring, recordkeeping and reporting requirements as follows:
    a. Heat input rates must be enforceable. Coal firing rates and trona feed rates (tons/hr) must be recorded for each boiler.
    b. Stack tests for PM_{10} and $PM_{2.5}$ must be required every six months for the first two years. Upon demonstration of continuous compliance, the staggered schedule for boiler stack tests in Condition 37 of the proposed SOP may be followed.
    c. Emission limits that apply during all operating scenarios must be specified. Multiple operating scenarios with different limits represent intermittent controls and compliance determination under multiple scenarios is cumbersome.
    d. All plant data, including monitoring and testing records, must be made available to the public in a readily-accessible manner without the need for a FOIA request.

- Limits and compliance requirements of CAIR and CAMR, which will take effect soon after the SOP is issued, must be identified in the SOP.

Sincerely

Poul Hertel
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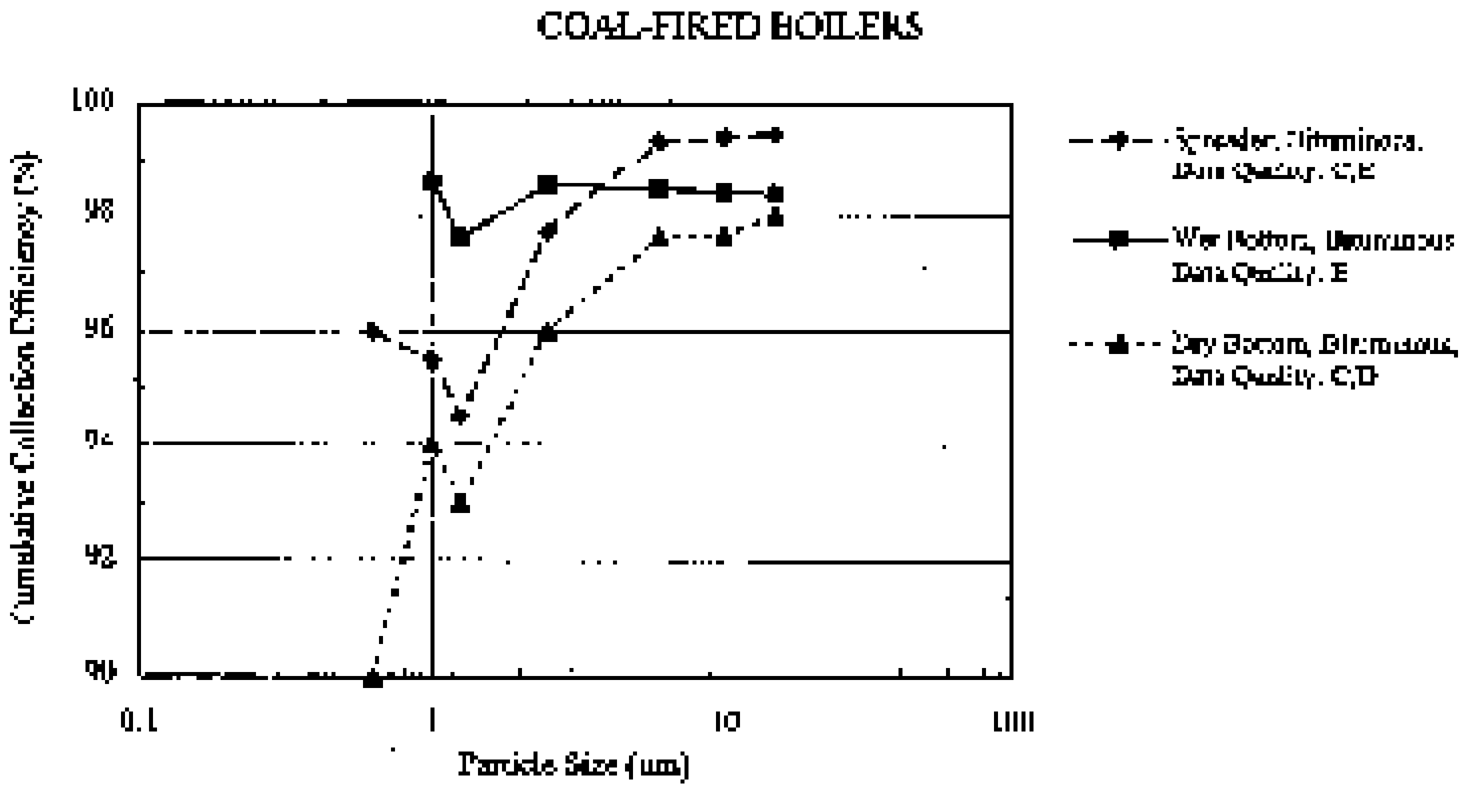
Alexandria, Va., 22314



Stationary Source Control techniques Document for Fine Particulate Matter

EPA CONTRACT NO. 68-D-98-026

WORK ASSIGNMENT NO. 0-08

Prepared for: Mr. Kenneth Woodard Integrated Policy and Strategies Group (MD-15) Air Quality Strategies and Standards Division U.S. Environmental Protection Agency October 1998 Submitted by: EC/R Incorporated

HEALTH EFFECTS

Research in the United States suggests that fine particulates are responsible for tens of thousands of deaths caused by increases in lung and heart disease. Fine particulate air pollution triggers many kinds of respiratory illnesses, including asthma, bronchitis, pneumonia and emphysema. Senior citizens, infants and people who already have lung, asthmatic or heart problems are most at risk, but healthy younger adults and children can also be affected. The connection between asthma and fine particulates is noteworthy since asthma is the most common cause of medical emergencies in children[1].

"Each 10μg/m^3 elevation in long-term average $PM_{2.5}$ ambient concentration was associated with approximately a 4%, 6%, and 8% increased risk of all-cause, cardiopulmonary, and lung-cancer mortality, respectively"

Pope et Al Journal of the American Medical Association March 2002

Varieties of pollutants affect our air quality. During the 1990s research provided evidence that fine particles can damage human health even at concentrations previously thought to be unimportant. Particles with a diameter of 10 microns (millionths of a metre) or less, termed PM_{10}, are the most hazardous[2].

PM_{10} are composed of a wide range of materials from a variety of sources:

- primary particles - arising from combustion sources
- secondary particles - mainly sulfate and nitrate formed by chemically combining Sulfur dioxide and nitrogen oxide with ammonia in the atmosphere.
- coarse particles - suspended soils and dusts, sea salt, biological particles and particles from construction work

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[1] Fine Particulates: What are they and how they affect us. February 2002. *Government of British Columbia; Ministry of Water, Land and Air Protection: Water, Air and Climate Change Branch*

See also the following two reports;
An Association between Air Pollution and Mortality in Six U.S. Cities
Douglas W. Dockery, C. Arden Pope, Xiping Xu, John D. Spengler, James H. Ware, Martha E. Fay, Benjamin G. Ferris, and Frank E. Speizer *New England Journal of Medicine* Volume 329:1753-1759 December 9, 1993 Number 24

Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality. *Health Effects Institute.* A Special Report of the Institute's Particle Epidemiology Reanalysis Project. Final version, July 2000.

[2] An Association between Air Pollution and Mortality in Six U.S. Cities Douglas W. Dockery et al 1993 Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality. *Health Effects Institute.* Final version, July 2000.

Not all PM_{10} are created equal. It can be composed of very small particulates of about 0.1 to 0.2 microns in diameter. To simplify things, the literature often refers to a fine and coarse fraction of PM_{10}, since they generally differ in chemical composition source and behavior in the air:

- The fine fraction ($PM_{2.5)}$) contains particulates 2.5 microns or smaller. This fraction is most often generated by combustion processes and by chemical reactions taking place in the air.

From our lungs' point of view, bigger particulates are less harmful. Because of their weight, particulates larger than 10 micrometers settle to the ground quickly. If we do inhale them, they tend to collect in our throat and nose, the upper respiratory system, and are eliminated from our body by sneezing, coughing, nose blowing or through the digestive system. In other words, they do not travel very far into our lungs. They contain materials common to the crust of the earth and the ocean, reflecting the fact that natural sources such as windblown dust and sea salt spray are big contributors to the coarse fraction.

In contrast, particulates in the fine fraction ($PM_{2.5}$) can remain in the air for days to weeks. They can penetrate especially deep into our lungs, collecting in the tiny air sacs (called "alveoli") where oxygen enters the bloodstream. Consequently, they can cause breathing difficulties and sometimes, permanent lung damage.

Studies

"Epidemiological work conducted over several decades has shown that long-term residence in cities with elevated ambient levels of air pollution from combustion sources is associated with increased mortality"[3]. Subsequent studies found a strong relationship between not only sulfates and mortality but also fine particulate matter (all particles less than 2.5 microns in median aerodynamic diameter [$PM_{2.5}$]) and mortality rates.

Conclusive evidence of the adverse effects of air pollution and mortality has been around for years[4]. However, recent research has focused on a more narrow scope of parameters. These studies demonstrated conclusively that the pollution levels needed for harmful effects were much smaller than expected and that fine particulate matter contributes to excess mortality[5]. These findings included statistical techniques in which individual risk factors, like smoking habits, were factored into the study.

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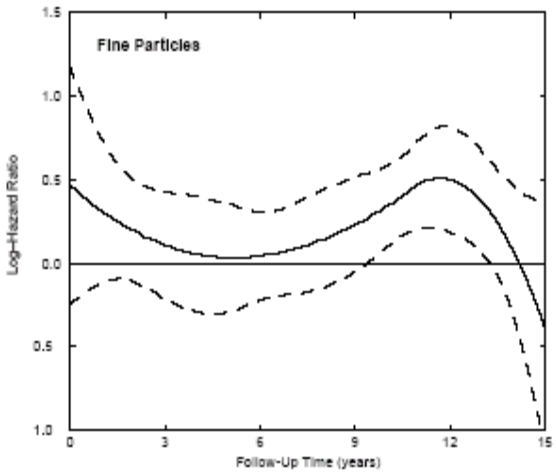
[3] Particle Epidemiology Reanalysis Project © 2000 Health Effects Institute, Cambridge MA

[4] See Firket J, The Cause of the symptoms found in the Meuse Balley during the fog of December, *1930 Bulletin Acad R Med Belgium.* 1931; 11:683-741
Ciocco A, Thomson DJ. A follow up of Donora ten years after: methology and findings. *American Journal of Public Health*. 1961; 51:155-164

[5] Abbey DE, Nishino N, Mcdonnell WF, Burchette RJ, Knutsen SF, Baeson LW, Yang JX. 1999 Long Term inhalable particles and other air pollutants related to mortality in nonsmokers. *American Journal Crit Care Med* 159(2):373-38

The seminal study by Dockery[6] and colleagues, the Harvard Six Cities study, found that fine particulate matter contributes to excess mortality (see figure below for time profile). In a similar study, Pope[7] and colleagues (American Cancer Society Study) reported that increased mortality in the form of cardiopulmonary disease and lung cancer was caused by fine particulate matter, sulfates, and does so at pollution levels commonly found in US cities. These studies hastened a new set of guidelines for $PM_{2.5}$ levels of acceptability by the Environmental Protection Agency.



"Both estimates suggest that the respective hazard ratio is a nonmonotone function of the follow up time. Specifically, the impact of fine particles on the mortality hazard decreases to near zero after five years of follow up, but later increases to reach a peak at about 10 to 12 years of follow up."
Harvard Six Cities Study, page 152

The business community challenged the validity of the studies and the legal wherewithal of the EPA to implement new guidelines, which prompted the EPA to seek validation of the original findings. Consequently, the EPA urged Harvard University and the American Cancer Society to allow other scientists to review their data. Consequently, Harvard University asked the Health Effects Institute (HEI) to review the studies in order to ascertain the validity of the conclusions. A full copy of the study[8] is available from the HEI web Site and it is voluminous and technical. Nevertheless, it does validate the original findings and mortality rates associated with the fine particulates.

In the March 2002 issue of the Journal of the American Medical Association Pope[9] and Colleagues assessed the effects of long term exposure to the fine particulate air pollution.

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[6] Dockery DW, Pope CA, XU X, SpenglerJD, Ware JH, Fay ME, Ferris BG, SpeizerFE, 1993. An association between air pollution and mortality in six US cities. *New England Journal of Medicine* 329: 1753-1759

[7] Pope CA, Thun MJ, Namboodiri MM, Dockery DW, SpenglerJD, Evans JS, SpeizerFE, Heath CW. 1995. Particulate air pollution as a predictor of mortality in a prospective study of US Adults. *American J Respir Crit Care Med* 151: 669-674

[8] Re-Analysis of The Harvard Six Cities Study and The American Cancer Society Study of Particulate Air Pollution and Mortality A special Report of the Institutes Particle Epidemiology Reanalysis Project; July 2000 *The Health Effects Institute.*

[9] Pope CA, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, ThurstonGD. 2002. Lung, Cancer, Cardiopulmonary Mortality and Long Term Exposure to Fine Particulate Air Pollution. *Journal of the American Medical Association*: March 6 2002: 1132-1141

The authors found that there was an effect and that the effect persisted over time. "For every increase in each $10\mu g/m^3$ elevation in long-term average $PM_{2.5}$ ambient concentration was associated with approximately a 4%, 6%, and 8% increased risk in all-cause, cardiopulmonary, and lung-cancer mortality, respectively."[10]

The function is linear, meaning that the greater the exposure the greater the risk. Furthermore, correcting mortality rates for other adverse effects, such as tobacco smoking, drinking, obesity and location effects, does not alter the evidence of fine particulate matter on mortality.

Fly Ash[11]

The connection between Fly ash and health issues is important and yet very difficult to clarify. Because approximately 20% - 40% of fly ash particles are below 7 microns in diameter, they are in the respirable[12] range and absorbed by the deeper lung tissue. The study below demonstrates not only the adverse effects of fly ash on health, but also the connection between the size of the particulate matter and the effect on health. The smaller the particulates, the greater the effect.

During the past decade, research has consistently demonstrated the connection between inhaled particulate matter with both acute and chronic health effects. Although much research has been directed toward identifying plausible mechanisms linking particulate matter and pathophysiologic effects, many critical aspects are not understood. Dr. Ann E Aust [13] focused on the effects of fly ash, the particulate residue from coal-fired power plants. Coal contains metals that vaporize during combustion and then solubilized from fly ash within lung cells may cause toxic reactions.

The study confirmed that soluble extracts of coal fly ash generated reactive oxygen species in vitro and that transition metals were likely responsible. "Further, the smallest particles, which were rich in iron, were the most active."[14] This means that more iron was released from the smaller particles than from larger ones. The investigators then examined the effects of coal fly ash on human lung epithelial (tissue-layered) cells in culture. First, they demonstrated that coal fly ash particles entered the cells and stimulated synthesis of the protein ferritin. Ferritin binds iron and is produced in response

[10] See Pope et al 2002

[11] The inorganic residue, that remains after pulverized coal is burned, is known as 'coal combustion byproducts' (CCB). Fly Ash is the finely-divided CCB collected by electrostatic precipitators from the flue gases. Boiler slag and bottom ash are the heavier and coarser coal combustion byproducts. The picture is from the Fly Ash resource Center Web site.

[12] Fly Ash Center, Fly Ash Safety Sheet

[13] Dr Ann E Aust of Utah State University, Logan UT. The complete report, Particle Characteristics Responsible for Effects on Human Lung Epithelial Cells, can be requested from Health Effects Institute. AUST 110

[14] Aust et al Statement Synopsis of Research Report 110 *Health Effects Institute*

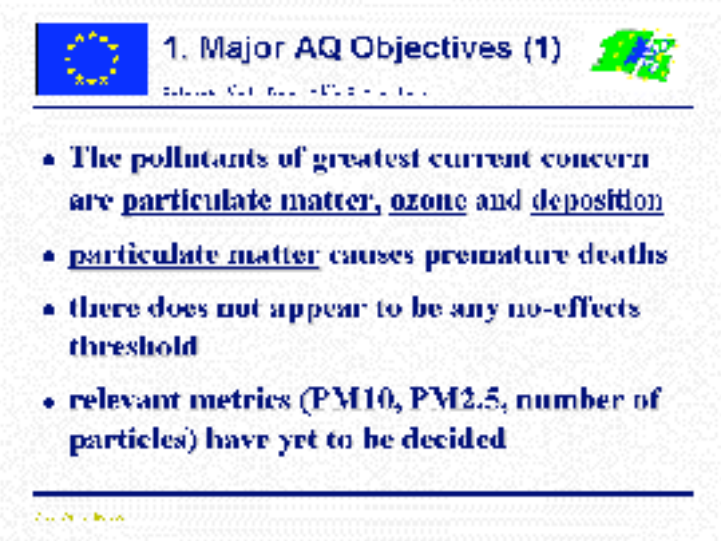
to increasing iron levels; thus, its presence indicates that iron was released intracellularly and that iron was available to provoke an inflammatory response by forming reactive oxygen species.

Latest Developments

Over the past decade, time-series studies conducted in many cities have contributed information about the association between daily changes in concentrations of airborne particulate matter (PM) and daily morbidity and mortality. In 2002, however, investigators at Johns Hopkins University and at Health Canada identified issues in the statistical model used in the majority of time-series studies. The authors suggested that there was a problem with the statistical software package used to analyze the data, because the convergence criteria might have been too loose. Consequently, the Environmental Protection Agency asked the Health Effects Institute to review all the studies using appropriate corrective measures. The Special Report details[15] the attempts to address several questions raised by these discoveries.

The impact of using more appropriate statistical convergence criteria on the estimates of PM effect in the revised analyses varied greatly across the studies. In some studies, stricter convergence criteria had little impact, and in a few the impact was substantial. "In no study were conclusions based on the original analyses changed in a meaningful way by the use of stricter criteria."[16]

In the European Community, the debate accepts that particulate matter is harmful, and is instead focused on how to regulate particles in the size of 2.5 to 10 microns in urban areas (see the European Commission Objectives to the right[17]). Furthermore, they recognize that the scientific studies have not been able to find a lower limit of exposure under which they can observe no health effects.



[15] Special Report, Revised Analyses of Time-Series Studies of Air Pollution and Health; May 2003 *Health Effects Institute*.

[16] Synopsis of a Special Report Revised Analyses of Time-Series Studies of Air Pollution *Health Effects Institute*

[17] Workshop in support of the Clean Air for Europe (CAFE) programme of DG ENV in Berlin, Germany, November 4-6, 2002; Why the Coarse fraction of PM10 is important for air quality management.
Jacobi, Stefan *European Commission*, DG Environment, Brüssel, Belgien

PLANT OPERATION CONCERNS

The Mirant plant has the capacity to produce over 480 Megawatts of power a year. Because of its proximity to Reagan National Airport, the smokestacks (chimneys) are very short, unlike those of most coal-powered plants.

The inorganic residue, that remains after pulverized coal is burned, is known as 'coal combustion byproducts' (CCB). Fly Ash is the finely divided CCB collected by electrostatic precipitators after the combustion process. Subsequently, hammers hit the electrostatic precipitators to release the particulates. As the particulates fall, they are sifted into the ash house silo, which are essentially huge vacuum cleaners that use fabric filters (bags) to trap the particles. **According to the Mirant plant's consultant study, 29 tons per year of particulates are not captured by the bags and escape directly into the atmosphere. With the addition of a second ash house silo, this number could be reduced by 50%[18].**

The operational sources of emission and residue from the plant can be summarized as follows:

- Stacks/Chimneys

  Primary and secondary particulates from burning up to 4800 tons coal/day and 3800 tons/day on average.

- Ash House Silos

  The operation is not 100% effective since the Ash House silo bags capture only particulates above a certain size. The fly ash captured in the ash house silo requires 30-35 truck trips per day for removal from the property.

- Coal Pile

  Coal crushing and piling operations susceptible to wind currents.

[18] This was disclosed at a meeting, August 15, 2001 at the Mirant Plant, convened to discuss the consultant's study results. City staff was also present.

CONCLUSION

As stated in the Introduction, we initiated this study in Spring 2001 to scientifically determine the source of our neighborhood residue. Pursuing that answer, both the Mitchell/Penn State and the Virginia Department of Environmental Quality analyses have confirmed that a large part of the residue originates at the Mirant Potomac River power plant. Further, the Levy et al., as well as studies in the Health Effects section, which are encapsulated by the Pope et al./JAMA article, have established the hazardous health effects associated with $PM_{2.5}$ emissions from power plants. In particular, the Levy study provides quantitative information on the health impacts as well as benefits for Alexandria's Potomac River plant, if best available control technology (BACT) were installed.

In conclusion, this scientific data validates and intensifies our original concerns regarding the residue emanating from the power plant. The empirical research, collected over a two and half year period, consistently demonstrates the health dangers and risks associated with coal burning power plants. Furthermore, these health effects impact not only North Old Town, but also the entire city. Therefore, remediation is needed to protect the health of all Alexandria citizens.

LIST of SOURCES

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Fine Particulates[19]

What are fine particulates?

Particulates are airborne tiny solid or liquid droplets of many shapes and sizes that come from a variety of sources. Some of these coarse particles - such as soot or smoke -- are large or dark enough to be seen by the naked eye. They are referred to as PM-10 since they are "particulate matter" 10 microns or smaller in size. These larger particulates are emitted from roads, materials handling, crushing and grinding operations and include wind borne dust.

Other particulates are so small they can only be seen with special microscopes. These "fine" particles measure less than 2.5 microns in diameter -- PM-2.5 - and are about the size of bacteria. These minuscule particulates are of particular concern since they can become lodged deep into the lungs and typically contain greater amounts of toxic substances than larger particulates.

A number of harmful substances have been found in $PM_{2.5}$:

- Sulphates produced from sulphur dioxide emissions are acidic in nature, and may react directly with our lungs.

- Elemental carbon produced during wood and engine combustion can pick up cancer-causing chemicals like benzo(a)pyrene and give them a free ride into our lungs.

- Hundreds of organic carbon compounds, besides benzo(a)pyrene, have been identified in exhaust from vehicles, combustion processes and even meat-cooking operations.

- Several studies have shown that toxic trace metals such as lead, cadmium and nickel are more concentrated in $PM_{2.5}$ than in bigger particulates.

Combusting fossil fuels such as coal, oil, diesel fuel or gasoline is the primary source of fine particulate pollution. In particular old coal-fired power plants, industrial boilers, diesel and gas-powered vehicles, as well as wood stoves, are the principal sources of fine particulates.

From our lungs' point of view, bigger particulates are less harmful. Because of their weight, particulates larger than 10 micrometers settle to the ground quickly. If we do inhale them, they tend to collect in our throat and nose, and are eliminated from our body by sneezing, coughing, nose blowing or through the digestive system.

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19 Fine Particulates: What They Are and How They Affect Us Ministry of Water, Land and Air Protection, Government of British Columbia.
http://wlapwww.gov.bc.ca/air/particulates/fpwtaaht.html

Particulates in the coarse fraction of PM_{10} are removed in the upper respiratory system. In other words, they don't travel very far into our lungs. They contain materials common to the earth's crust and the ocean, reflecting the fact that natural sources such as windblown dust and sea salt spray are big contributors to the coarse fraction.

Vegetation is another large natural source. Human activities that involve grinding or pulverizing, such as mining, quarrying and cement manufacturing, are also important. These particulates don't stay in the air too long, settling to the ground within a matter of a few hours to a few days.

In contrast, particulates in the fine fraction ($PM_{2.5}$) can remain in the air for days to weeks. They can penetrate especially deep into our lungs, collecting in the tiny air sacs (called "alveoli") where oxygen enters the bloodstream. As a result, they can cause breathing difficulties and sometimes permanent lung damage.

MERCURY[20]

Although not part of the study, mercury emissions are becoming a greater concern associated with coal plants. Hence, this section is included for general informative purposes.

Mercury is present in trace amounts in coal and is released as a gas when coal is combusted. Growing concern over potential environmental effects of mercury is reflected by the move towards establishing emissions limits for sources such as coal combustion. For example, according to the International Energy Agency (IEA), mercury controls will be a legal requirement for many coal-fired plants in the USA by 2007.

Recent data from the Information Collection Request carried out in the USA have resulted in an increase in the understanding of mercury behavior in coal-fired systems. The retention of mercury within a coal-fired power plant depends largely upon its oxidation state. Soluble oxidized mercury is controlled with existing pollution control technologies such as bag houses, electrostatic precipitators (ESP) and flue gas desulferization (FGD) systems. Insoluble elemental mercury passes through the plant largely uncaptured. Chlorine and other flue gases can play a major role in the mercury oxidation state. There appears to be a strong relationship between coal type and mercury oxidation. In general, US bituminous coals produce more mercury in the oxidized state than sub-bituminous coals and lignite.

Average mercury removal across various pollution control devices for different coal ranks

Control device	Temperature, °C	Bituminous coal		Subbituminous coal		Lignite		All coals	
		Hg removal	data*	Hg removal	data*	Hg removal	data*		
Cold side ESP	130-170	56%	9	12%	4	47%	1	42%	14
Hot side ESP	250-400	27%	3	9%	2			20%	3
Baghouse	130-170	85%	7	75%	2	58%	1	82%	10
Wet scrubbers	130-170							26%	2
Wet FGD + cold ESP	130-170	51%	7	27%	3	48%	4	45%	14
Wet FGD + hot ESP	130-170			35%	3			35%	3
Wet FGD + baghouse	130-170					73%	2	73%	2
Wet FGD + wet scrubber	130-170	12%	1	18%	2			16%	3
Spray dry FGD + ESP	130-170			53%	2			53%	2
Spray dry FGD + baghouse	130-170	83%	5	22%	2	25%	3	53%	10

* number of plants studied

IEA Coal Research

"Existing pollution control systems can remove up to 90% of the incoming coal's mercury content in some cases but very little in others". Furthermore, the coal type is more important than the type of particulate control system or the type of FGD system with respect to mercury control.

[20] Mercury – emissions and control *International Energy Agency*
IEA Coal Research is a collaborative project of member countries of the International Energy Agency (IEA) to provide information about and analysis of coal technology, supply and use. The service is governed by representatives of ten countries (Austria, Canada, Denmark, Italy, Japan, the Netherlands, Poland, Sweden, the United Kingdom and the USA) and the European Commission.